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Paper Session I-C - Seeds II: More Tomatoes from Space

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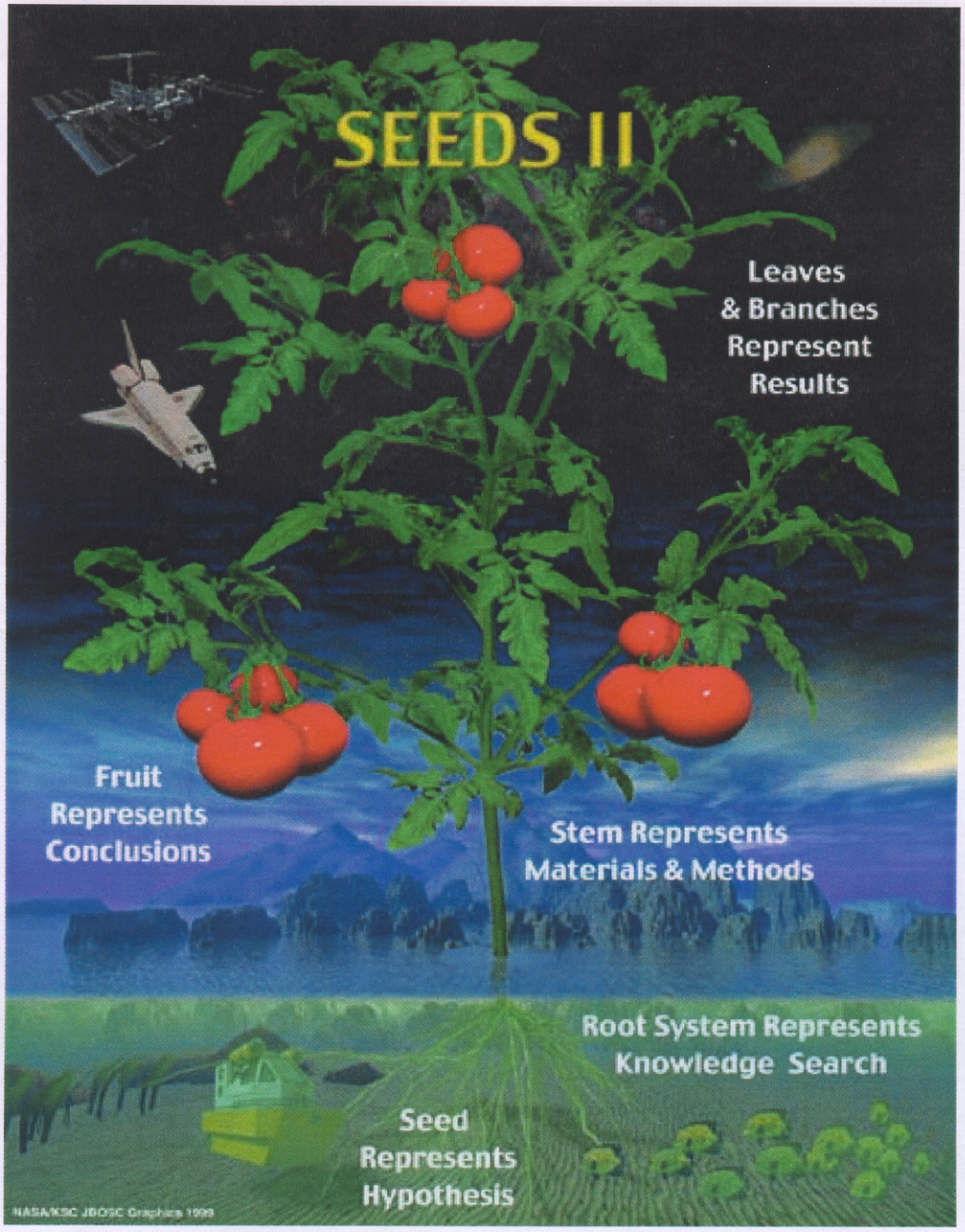

SEEDS II: More Tomatoes from Space! (For Classroom Research)

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Abstract:

NASA Life Sciences Outreach, in collaboration with several other organizations, is getting ready to release space exposed seeds to teachers and students. This project, called Space Exposed Experiment Developed for Students II (SEEDS II) was designed to provide teachers and students with seeds and information so that they can conduct biological research relating to the effects of the space and undersea environments. SEEDS II is a joint effort between NASA Life Sciences Outreach, the Glenn Research Center, the Kennedy Space Center Biomedical Office, and the George W. Park Seed Company. Tomato seeds were exposed to the vacuum of space for nine days, aboard STS-86. Additional seeds were exposed to the increased pressure of an underwater environment aboard an underwater habitat during the same period, in the waters near Key Largo, Florida. Seeds from the same lot were maintained at the Park Seed Company as a control group. The SEEDS II kits that will be distributed will contain packets of ground control, underwater habitat, and space shuttle exposed seed. The kit also contains a poster and booklet describing methods for growing the tomatoes. NASA Life Sciences Outreach began distribution of the packets in October of 1999.

Tomatoes from Space!

NASA Life Sciences Outreach, in collaboration with several other organizations, is getting ready to release another batch of space exposed seeds to teachers and students. This project, called Space Exposed Experiment Developed for Students II or SEEDS II is designed to provide teachers and students with seeds and information so that they can conduct biological research relating to the effects of the space and undersea environments.

About SEEDS II

SEEDS II is a joint effort between the National Aeronautics and Space Administration (NASA) Life Sciences Outreach program, the NASA Glenn Research Center, the NASA Kennedy Space Center Biomedical Office and the George W. Park Seed Company of Greenwood, South Carolina.

For this project, tomato seeds were exposed to the vacuum of space for a period of nine days, aboard STS-86 mission of the Space Shuttle Atlantis. Identical seeds were exposed to the increased pressure of an underwater environment aboard NASA's underwater habitat, the Scott Carpenter Space Analog Station during a mission in the waters near Key Largo, Florida for an identical time period. Seeds from the same lot were maintained at the Park Seed Company in South Carolina as a control.

Before SEEDS II, there was SEEDS

This isn't the first time a project like this has been conducted. In the first SEEDS experiment, tomato seeds were exposed to the microgravity and radiation of space in sealed containers aboard the Long Duration Exposure Facility (LDEF). The LDEF, which carried 56 other experiments into space, was deployed in April,1984 on STS 41-C (Space Shuttle Challenger). It remained in orbit for over 5 years until it was retrieved during mission STS-32 (Space Shuttle Columbia). Like the current SEEDS II, the first seeds were packaged and distributed to schools around the country.

The differences between SEEDS and SEEDS II are the length of exposure to space and the inclusion of an underwater treatment. Thousands of school from the United States and thirty other countries took part in the project with many responding with research results. The results were compiled by NASA and published in SEEDS: A Celebration of Science. The goals of the program included promoting interest in science and the space program, and developing science process skills among students of all ages, through participation in real space-related research.

The Contents of the SEEDS II Kit

The SEEDS II kits that are distributed contain packets of ground control, underwater habitat, and space shuttle exposed seed. Each packet contain approximately 20 seeds. In addition, each kit contains a poster and guide describing methods for developing an experiment and growing the tomatoes. The Educator's Guide (Figure 1) contains detailed information on the scientific process, explanations about the history of the seeds within each of the three foil packets, and suggestions for designing, preparing, and conducting a plant biology experiment. In addition, there is a listing of print and web-based resources. The full-color, SEEDS II poster illustrates the parts of a growing tomato plant and the steps of the scientific process. The back of the poster is formatted for ease of reproduction. Educators or group leaders may wish to produce additional resource copies of the articles The Importance of Plants in Space and "Grow" and Experiment. NASA Life Sciences Outreach began distribution in October of 1999.

Partnerships in Preparation and Distribution of SEEDS II

Eighty-thousand kits were assembled by the Brevard Achievement Center in Rockledge, Florida. This is a non-profit organization which combines employment and training for challenged individuals. The distribution of the kits is being implemented by a number of partner organizatrions. The Star Station One Institute (SSI) is a consortium of museums and science centers focusing on the construction and utilization of the International Space Station. SSI includes Space Center Houston and the Bishop

Museum and will be distributing 16,000 kits. The Challenger Centers are planning a nationwide distribution of an additional 30,000 kits.

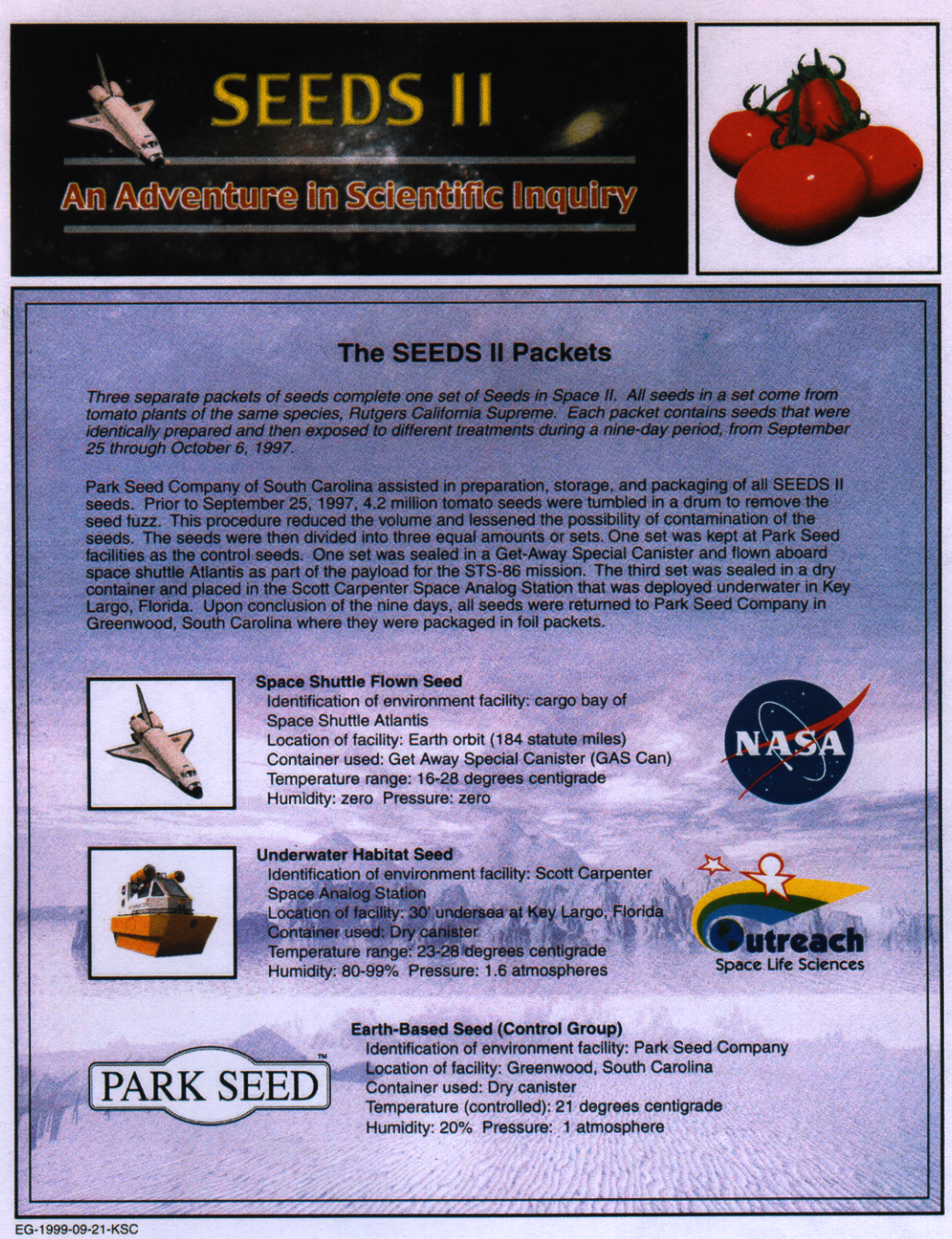

Figure 1. The cover of the SEEDS II Educator Guide describing the mission and the environmental conditions to which each set of seeds was exposed.

The Life Sciences Educator Network, an organization of about two dozen teacners, will conduct in-service distributions in their local school districts. The Mission to America's Remarkable Students schools, The Ukraine Junior Academy of Sciences, and NASA Life Sciences Outreach Centers are also partnering to bring SEEDS II to the public. To date, the SEEDS II kits have been distributed by mail, at a teacher symposium in Kiev, Ukraine (Figure 2), at the National Association of Biology Teachers Annual Convention (Figure 3), and the annual meeting of the American Society for Gravitational and Space Biology.

Figure 2. Ukrainian teachers are introduced to SEEDS II materials at a workshop at the Ecological Center in the city of Kiev, Ukraine.

Figure 3. SEEDS II materials being distributed at the National Association of Biology Teachers Convention in Fort Worth, Texas.

Plans are being made for distribution at the National Society of Science Teachers and National Association of Biology Teachers National Conventions in the year 2000, the American Society for Aging, the Association for the Advancement of Retired People, the Spaceflight and Life Sciences Training Program, Park Seed Company, and other various avenues for educational and public use.

Websites Pertinent to SEEDS II

- Life Sciences Data Archive:
http://lsda.jsc.nasa.gov/life.htm#top

- NASA Astrobiology Institute:
http://nai.arc.nasa.gov/

- American Society for Gravitational and Space Biology:
http://www.indstate.edu/asgsb/

- NASA Gravitational Biology and Ecology Home Page:
http://www.gravbio.nasa.gov/

- NSCORT in Bioregenerative Life Support:
http://www.rci.rutgers.edu/~biorengg/njnscort

- Tuskegee University:
http://agriculture.tusk.edu/AGEP/agep_main.html

- Utah State University:
http://www.usu.edu/~cpl/index.html

- Kennedy Space Center:
http://atlas.ksc.nasa.gov/celss/INTRO.HTM

- Johnson Space Center Homepage:
http://pet.jsc.nasa.gov/

- Ames Research Center Advanced Life Support (CELSS)
http://lifesci.arc.nasa.gov/home/html

- NASA Life Sciences classroom activities
http://webolife.arc.nasa.gov

- Classroom of the Future-BioBLAST
http://www.cotf.edu/BioBLAST

Book Resources Pertinent to SEEDS II

Darwin, C. 1880. The Power of Movement in Plants. J. Murray Publishing (London).

Hart, J.W. 1990. Plant Tropisms and Other Growth Movements. Unwin Hyman Publishing (London).

Kearns, C.A. and D.W. Inouye. 1993. Techniques for Pollination Biologists. Colorado University Press (Niewot, CO).

NASA. 1995. Life into Space. Space Life Sciences Experiments, NASA Ames Research Center, 1965-1990. NASA Reference Publication 1372, The National Aeronautics and Space Administration.

NASA. 1990. SEEDS Activity Book, Grades 5-9. U. S. Government Printing Office #1990 0-257-472:QL 3.

NASA. 1990. SEEDS Teacher's Guide. U. S. Government Printing Office #1990 0-256-866.

NASA. 1991. SEEDS: A Celebration of Science. NASA Educational Affairs Division Publication # EP-281.

National Council for Agricultural Education. 1994. Using Fast Plants and Bottle Biology in the Classroom. National Association of Biology Teachers (Reston, VA).

Suge, Hiroshi. (editor) 1996. Plants in Space Biology. Institute of Genetic Ecology, Tohoku University.

Raven, P.H., R.F. Evert and S.E. Eichorn. 1992. Biology of Plants. Worth Publishers (New York).

Additional NASA Life Sciences Outreach Resources

Description	Grade	Format
Essentials of Biology: a series of nine magazine style space life sciences articles.	7+	Printed
Exercise Book: a Guide from the National Institute on Aging and NASA.	Adults	Hardcopy
Garfield Factoids: interesting facts about life in space illustrated by Garfield (nice for coloring).	All	B & W handout
Garfield Poster: an 18" x 24" color poster using Garfield to inform the reader about space facts.	All	Poster
Human Physiology in Space: a high school student's manual and teacher's manual presenting six physiological systems on Earth and in space.	9-12	Website and Hardcopy
Life Sciences Poster: a general poster displaying Life Sciences images and the Outreach URL	All	Poster
SEEDS II: a science kit that includes a poster, a teacher's guide, and seeds	K-14	Hands-on science activity kit
SpaceLife ExPress: a youth newsmagazine focusing on space life sciences	K-4 5-8	Hardcopy
The Heart in Space: How Microgravity Affects the Cardiovascular System: an interactive multimedia tool for students	7 +	CD-ROM
The Vestibular System: Balance and Equilibrium in the Gravitational Continuum: an interactive multimedia tool for students	7 +	CD-ROM
Why do I Need a Space Suit? Activity Poster: the front of the 26" x 33" poster briefly presents the effects of microgravity on the human body. The back of the poster has 6 lessons that teacher can incorporate into the classroom curriculum.	5-12	Poster